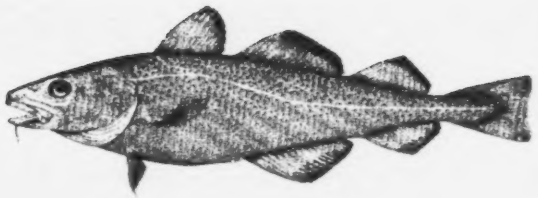
Fisheries and Oceans Canada | Pêches et Océans Canada
Ecosystems and Oceans Science | Sciences des écosystèmes et des océans

Quebec Region

Canadian Science Advisory Secretariat
Science Advisory Report 2017/042

ASSESSMENT OF THE NORTHERN GULF OF ST. LAWRENCE (3PN, 4RS) COD STOCK IN 2016



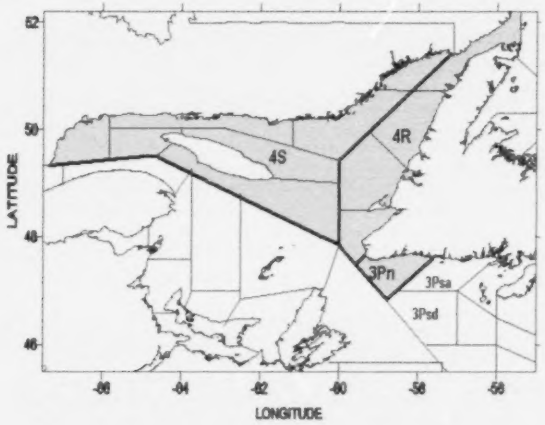


Figure 1. Cod stock management area in the Northern Gulf of St. Lawrence (3Pn, 4RS).

Context

The first total allowable catch (TAC) of the northern Gulf of St. Lawrence cod stock (NAFO subdivision 3Pn and divisions 4R and 4S) was 55,000 t in 1977. It reached a maximum of 100,000 t between 1983 and 1985. This fishery was then placed under two moratoriums (1994 to 1996 and 2003). Between 1974 and 1993, this stock was fished by Canadian fleets using fixed and mobile gear as well as by some foreign fleets using mobile gear. Since 1997, the majority of landings have been made by the Canadian fleet using fixed gear (handlines, longlines and gillnets) since mobile gear was not authorized. Recreational fishing has been practiced for several years although the harvest has not been well documented.

In 2010, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated the Laurentian North (3Pn, 4RS and 3Ps) cod population, part of which consists of northern Gulf of St. Lawrence (3Pn, 4RS) cod, as endangered, based essentially on the extent of the decline (78–89%) in adult abundance over three generations (30 years). A recovery potential assessment was conducted in 2011. The northern Gulf cod spawning stock biomass has been in the critical zone, well below the limit reference point, since 1990.

This resource is managed mainly by an annual total allowable catch (TAC). Several other management measures (number and types of gear, area closures during spawning and in winter (3Pn), observers, dockside monitoring, minimum size, bycatch monitoring, rules for the recreational fishing, etc.) are also enforced. Since 1999, the management year has started on May 15 of the current year and ended on May 14 of the following year.

This stock is assessed every two years using mainly data from commercial fisheries, sentinel programs (fixed and mobile gear) and the DFO research survey. This Science Advisory Report is from the February 23, 2017 meeting on the assessment of northern Gulf of St. Lawrence cod stocks.

August 2017

Canada

SUMMARY

- The TAC for the 2015–2016 and 2016–2017 fishing seasons was 1,500 t in accordance with the recovery plan, and the preliminary landings totalled 1,263 t and 1,312 t, respectively.
- In 2016, the recreational fishery season increased from 32 to 46 days. This fishery's catches are not known, though they have probably increased. An assessment of its catches is necessary.
- The three commercial fishery performance indices are increasing and well above their respective averages in 2015 and 2016. Fishers corroborate these trends, according to a survey conducted by the industry.
- Recently, the standardized catch rates of the longline and gillnet sentinel fishing programs have been increasing. In 2016, they exceeded the averages of their respective series (1995–2014).
- The abundance index from the DFO research survey has been increasing slightly since 2010 and has exceeded the series average (1990–2014) since 2014. The abundance index from the sentinel fishery trawl survey varies, without any clear trends, and is at the average level in 2016.
- The increase in cod abundance in the northern Gulf of St. Lawrence in recent years is mainly attributable to its increase in division 4S. Since 2013, the spatial distribution of cod has been similar to that observed in the early 1990s.
- In 2015 and 2016, the monthly cod condition indices were generally lower than the averages of their respective series. The observed values are nonetheless considered to be at acceptable levels.
- Natural mortality estimated by sequential population analysis (SPA) has remained high in recent years. Possible causes are predation by seals and unaccounted fishing mortality.
- The estimated exploitation rates from the SPA and tagging program are weak and have been below 0.1 since 2012.
- Recruitment at age three, as estimated by the SPA, has been increasing since 2003. The abundant cohorts of 2011, 2012 and to a lesser extent 2013 have been confirmed by several indicators. The spawning potential of these cohorts will reach its peak between 2017 and 2020.
- Projections for 2018 and 2019 indicate that, with an annual harvest of 1,800 t or 3,000 t, the mature biomass should increase by 20% and 17%, respectively.
- Although the spawning stock biomass has increased, it is in the critical zone, at 32% of the limit reference point based on the 2017 estimate. It would be sensible for the fishery to maintain a low mortality rate.

BACKGROUND

Species biology

In summer, 3Pn and 4RS Atlantic Cod (*Gadus morhua*) stock are distributed throughout the northern Gulf of St. Lawrence at depths of 50 to 200 metres. In winter, the fish gather off southwestern (3Pn) and southern (3Psa and 3Psd) Newfoundland at depths of 300 to 500 m. Tagging studies indicate that this stock is generally isolated from neighbouring stocks. There

seems to be little mixing with adjacent stocks (i.e. to the southwest (4T) and northeast (2J, 3KL) in summer, and to the southeast (3Ps) in winter).

Spawning takes place mainly in April and May at depths of 200 to 250 metres. The main breeding area is located off Port au Port (west coast of Newfoundland). Age at 50% maturity has varied over time for this stock and is currently between four and five years. After spawning, the eggs disperse with the currents, and in fall, juveniles return to deeper waters.

Cod have a varied diet (zooplankton, crustaceans, and pelagic and benthic fish). Large cod eat mainly herring, flatfish, cod and crab. Predation on northern Gulf cod is poorly documented but several studies conducted in the southern Gulf of St. Lawrence (4T) report potentially high grey seal predation, which would account for changes in distribution toward deeper waters and which would hinder the recovery of this stock.

Ecosystem

Every year, Fisheries and Oceans Canada (DFO) uses the Atlantic Zone Monitoring Program (AZMP) to assess prevailing physical oceanographic conditions in the Gulf of St. Lawrence. Compared to historical averages, the surface temperatures observed throughout the Gulf reflected average conditions in 2015 and warmer conditions in 2016. The channel-bottom temperature was warmer in 2015 and 2016. The water volume of the cold intermediate layer (CIL) in summer has been decreasing since 2015.

The northern Gulf of St. Lawrence includes areas with low dissolved oxygen concentrations (< 30%), mainly at the head of the channels and great depths. The cod seem to avoid these hypoxic waters according to the annual DFO survey conducted in August. The adjacent areas are nonetheless habitats that are conducive to cod.

Cod stocks in the northern (2J3KL) and southern Gulf of St. Lawrence (4T-4Vn) are in the critical zone, while the stock in the 3Ps subdivision is in the cautious zone according to the benchmarks established under the precautionary approach.

Fishery

Cod TAC and landings steadily declined from 1984 to 1993 in the northern Gulf of St. Lawrence (Figure 2). The fishery was under moratorium from 1994 to 1996 and in 2003. Landings ranged between 1,772 and 6,470 t between 2004 and 2011 for TACs ranging from 2,000 to 7,000 t (Table 1). Since 2012, the annual TAC has been 1,500 t and landings were 1,263 t and 1,312 t for 2015 and 2016 (preliminary data). In 2016, the recreational fishery season increased from 32 to 46 days. This fishery's catches are not known although they have probably increased.

Commercial fishery performance indices taken from logbook data for the fixed gear fleets (gillnet and longline, Newfoundland vessels under 35 feet and Quebec vessels under 45 feet) show an increase in catches per unit effort (CPUE) after the 2003 moratorium until 2006 and then a decrease until 2009. CPUEs have been increasing since 2009 (Figure 3). After these maximums were reached, CPUEs decreased until 2009 and then increased thereafter. In 2015 and 2016, these indices exceeded the average values of their respective series. The performance index for the commercial longline fishery (>45', Quebec Region) was more or less stable from 2007 to 2014. Since 2015, it has been well above the 1998–2014 average (Figure 4).

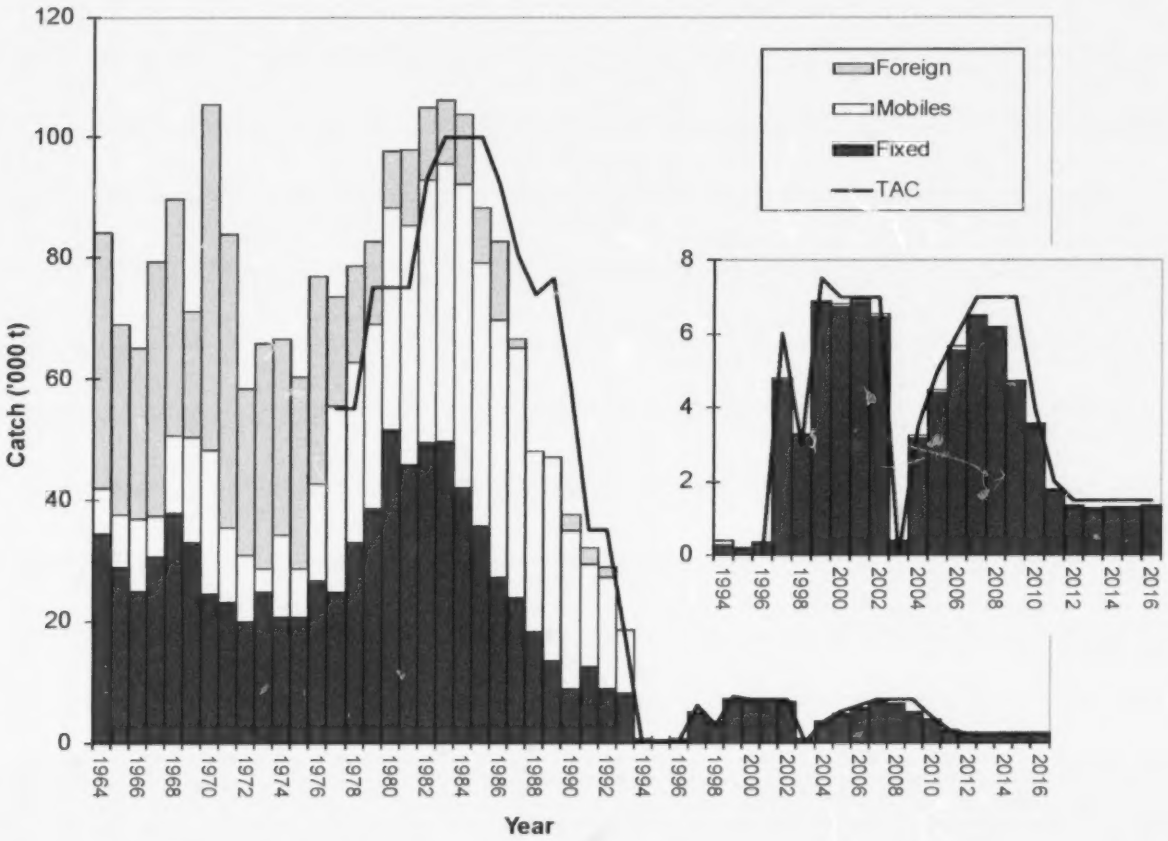


Figure 2. Annual landings and total allowable catch (TAC) by management year. (1964-1998: management by calendar year; 1999: TAC from January 1, 1999, to May 14, 2000; 2000 to 2016: TAC from May 15 to May 14 of the following year).

Table 1. Cod TAC and landings (in thousands of tonnes) in divisions 3Pn and 4RS.

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
TAC	5	6	7	7	7	4	2	1.5	1.5	1.5	1.5	1.5
Landings	4.5	5.7[1]	6.5	6.2[2]	4.7	3.6	1.8	1.3	1.2	1.2	1.3[3]	1.3[3]

[1] Includes 75 t from the recreational fishery
[2] Includes 67 t from the recreational fishery
[3] Preliminary data

Since 2004, more than 85% of cod landings have come from the directed cod fishery. Cod bycatch landings are low and mainly occur in the directed Atlantic Halibut and Greenland Halibut fisheries, whereas bycatches in the directed northern Gulf cod fishery below 10% t essentially consist of Greenland Halibut and Atlantic Halibut.

Cod is also a bycatch that is not accounted for in shrimp fishery landing statistics. These catches are of 1 kg or less per tow, and the cod caught are small (under 30 cm) (1–2 years). An analysis of the at-seat observer database indicates that cod is caught in slightly more than 20% of shrimp tows. In number, these catches represent less than 1% of biomass estimates from the DFO survey.

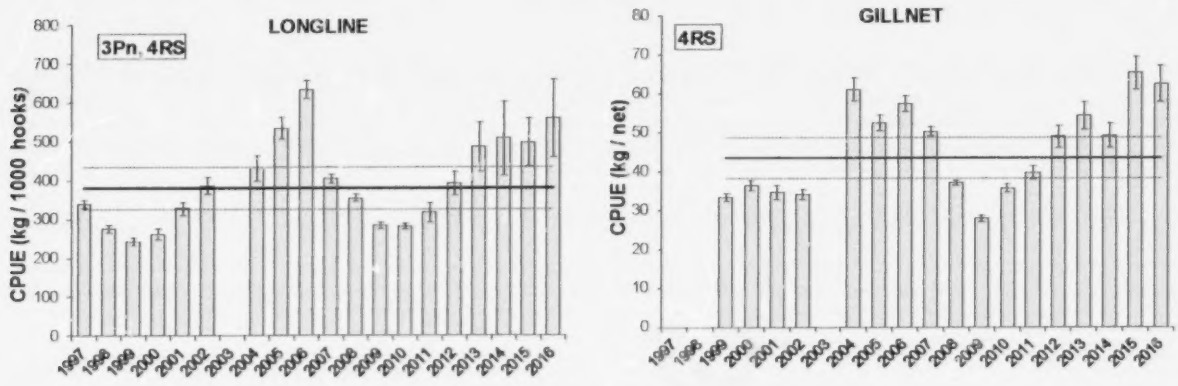


Figure 3. Catch per unit effort (CPUE) ±95% CI calculated from commercial fishery logbooks for Quebec vessels (< 45 feet) and Newfoundland (< 35 feet) from 1997 to 2016. The solid line represents the series average (1997 or 1999 to 2014) and the dotted lines ±½ the standard deviation around the average.

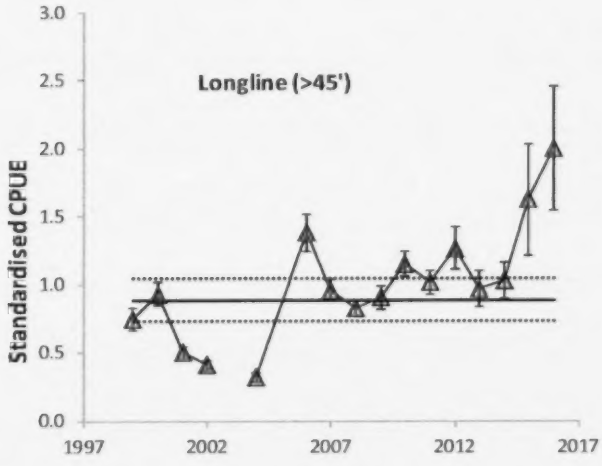


Figure 4. Catch per unit effort (CPUE) ± 95% CI calculated from commercial fishery logbooks for Quebec longliners (> 45 feet). The solid line represents the series average (1998 to 2014) and the dotted lines ±½ the standard deviation around the average.

ASSESSMENT

Sources of information

The status of cod stock in the northern Gulf of St. Lawrence was assessed using data from commercial fisheries (landings, number at age, fishery performance index), a tagging program (exploitation rate), an abundance index calculated from the DFO research survey (4RS, 1990 to 2016), abundance indices from the fixed gear sentinel program (gillnets and longlines, 1995 to 2016), an abundance index derived from the mobile gear sentinel fishery program (3Pn, 4RS, 1995-2016), biological data (including fecundity and maturity) from annual surveys dating back to 2002 (except 2003) and cod condition data collected annually since 1998.

Stock status

Biological data

Physical cod condition monitoring conducted mainly as part of the sentinel fisheries program shows an annual cycle. The condition index is lower in spring before spawning and then increases from summer to fall when it peaks. In 2015 and 2016, the values expressed using Fulton's index (somatic K) were lower than the 1998 to 2014 average. In 2015 and 2016, the hepatosomatic index (HSI), which further monitors the recent fish feeding success, also displayed values below the 1998 to 2014 average, mainly from July to November. The observed values are nonetheless considered to be at acceptable levels.

DFO survey

The mean number and mean weight per cod tow have been generally low and stable since 1992 (Figure 5). Since 2014, an increase has been observed in these indices, which are above the 1990–2014 series average. In 2016, the wide range of the size frequency distribution shows the presence of recent cohorts (2011 to 2013) and older individuals (2004 to 2006 cohort).

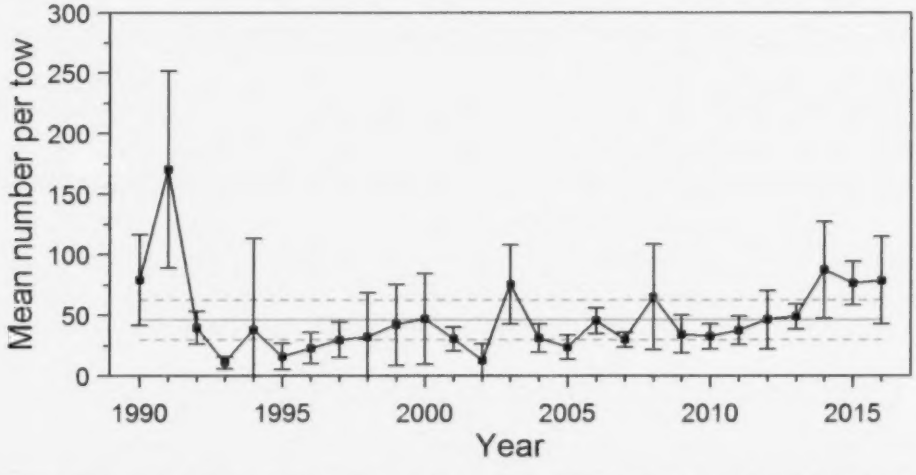


Figure 5. Mean number of cod per tow from the DFO survey in 4RS. The error bars indicate the 95% confidence interval. The horizontal lines indicate the average for the 1990–2014 period (solid line) and the upper and lower reference limits (dotted lines).

Cod distribution in the northeastern Gulf (4R) remained similar to that from 1994 to 2016, whereas in the western Gulf, cod concentrations show a gradual decline from 1995 to 2006. From 2007 onward, the spatial distribution of cod expanded in Division 4S, especially north and west of Anticosti Island. Lastly, recent (2013–2016) cod distribution is now similar to that observed in the early 1990s (1990–1994) (Figure 6).

Mobile gear sentinel fishery

The sentinel bottom trawl fisheries index comes from stratified random surveys conducted in July in areas 3Pn, 4R and 4S. It includes two periods: 1995 to 2002, involving only depth strata of more than 20 fathoms; and from 2003 onward, when three 10- to 20-fathom strata were added to those previously sampled. This index does not indicate a clear trend (Figure 7). The 2015 values (mean number and weight per tow) are above the 2003–2014 average, while the 2016 values are close to the average.

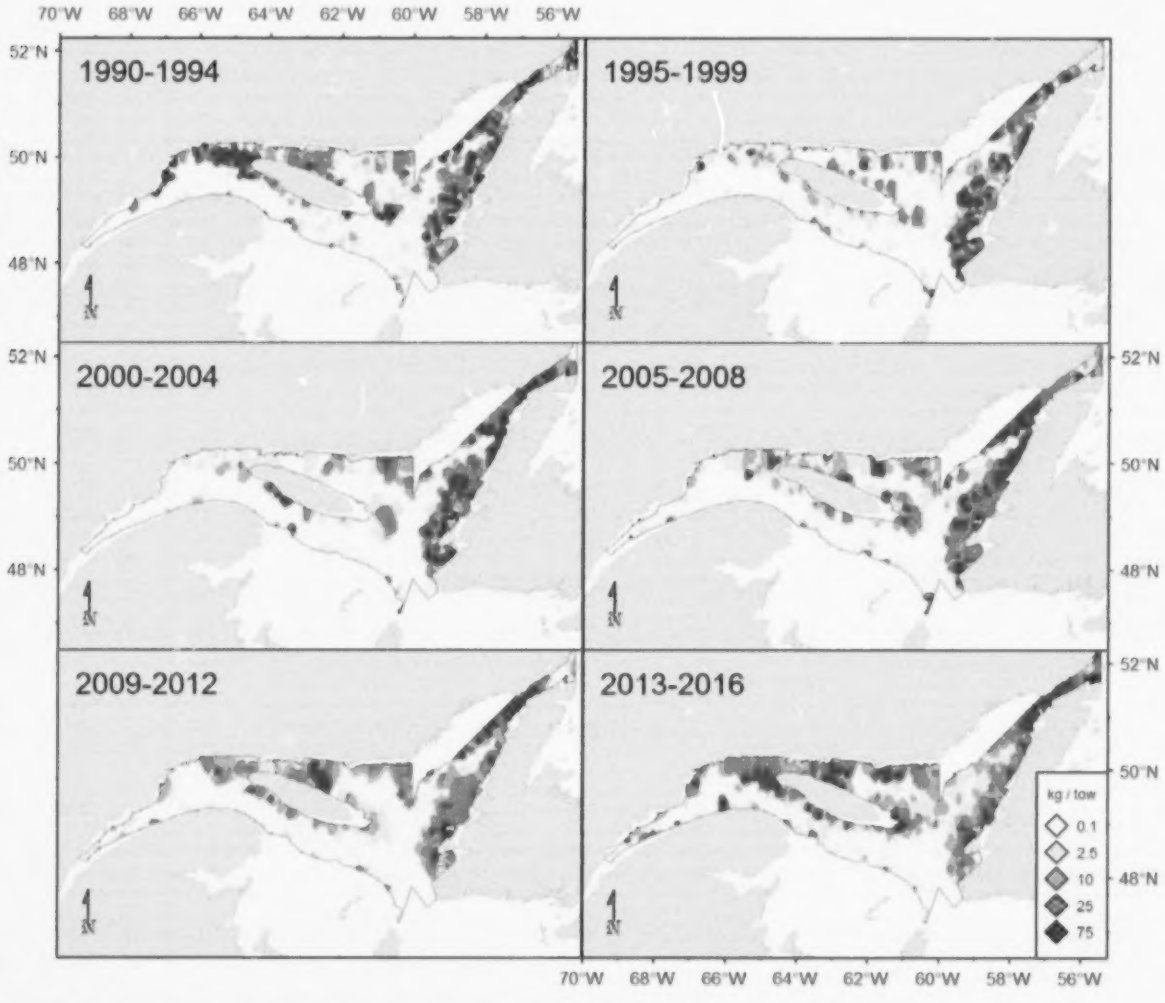


Figure 6. Distribution of cod catch rates (kg/15-minute tow) in the DFO survey in 4RS.

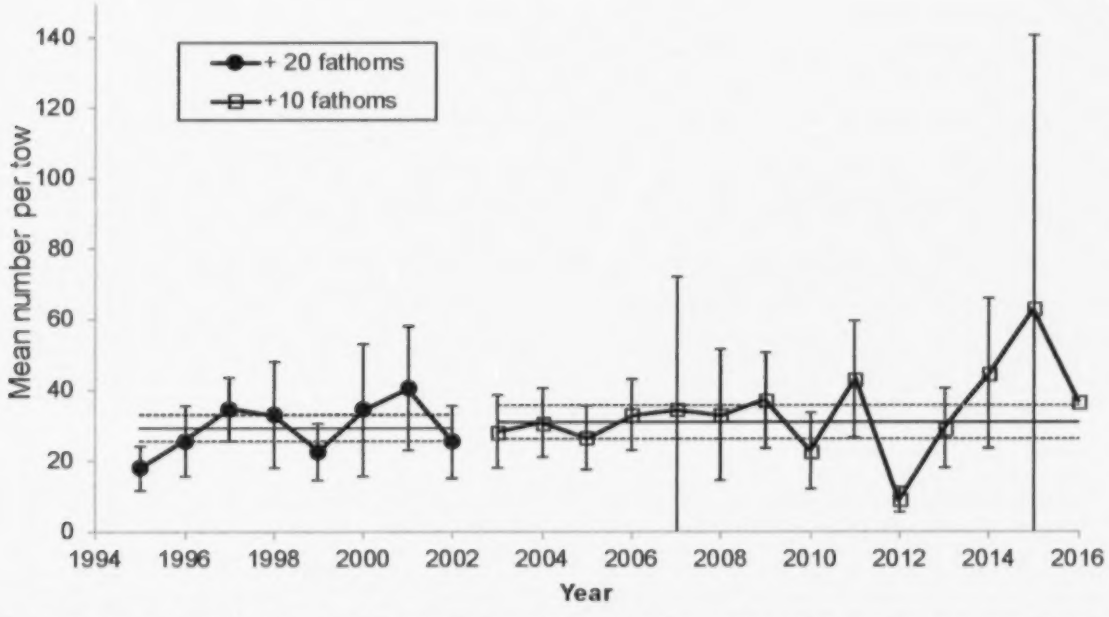


Figure 7. Mean number of cod per 30-minute tow (±95% confidence interval) during the July mobile gear sentinel fisheries survey. The solid lines represent the averages for each series (1995-2002, 20 fathoms or more; 2003-2016, 10 fathoms or more) and the dotted lines ±½ the standard deviation around the average.

Fixed gear sentinel fishery

CPUEs from the fixed gear sentinel fisheries program (gillnet and longline) have been used as abundance indices in cod assessments since 1998. Data are collected at 24 sites along the coastlines in 3Pn, 4R and 4S. Average gear deployment depths are 90 m for longline and 80 m for gillnet. The longline index increased between 1995 and 2006 then decreased, reaching its low in 2010. It then generally increased until 2016 to reach a value well above the series average (1995–2014). The gillnet index shows a similar pattern and the 2015 and 2016 values are well above the 1995–2014 series average (Figure 8).

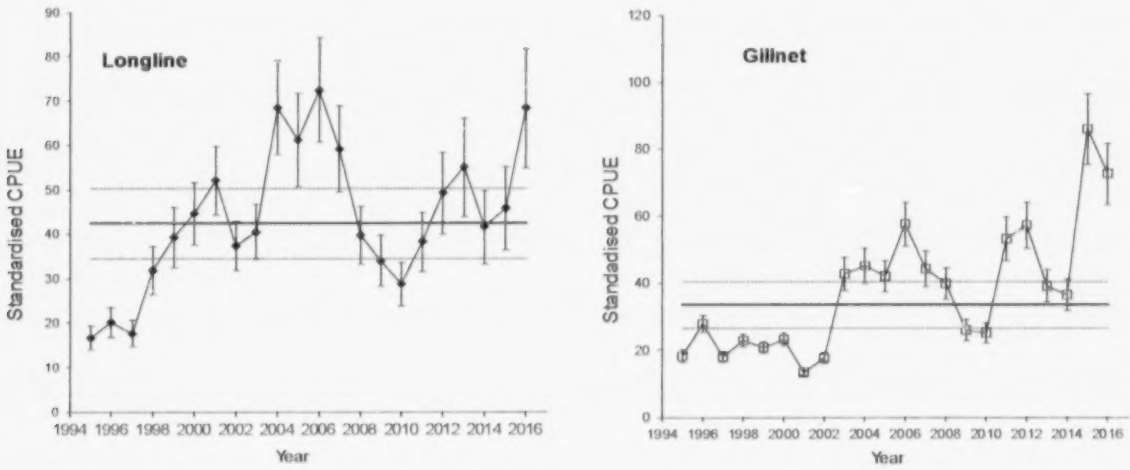


Figure 8. Standardized catch per unit effort (CPUE) for the fixed gear sentinel fisheries program. The solid line represents the 1995–2014 series average and the dotted lines ±½ the standard deviation around the average. The error bars indicate the 95% confidence interval.

Sequential population analysis

A sequential population analysis (SPA), conducted using NFT ADAPT, was used to estimate several northern Gulf of St. Lawrence cod stock status parameters, including exploitation rate, population abundance, spawning stock biomass (SSB) and natural mortality (*M*). Natural mortality includes all potential mortality sources that are not accounted for in catch statistics (*F*). The SPA is based on catches at age in the commercial fishery, and estimated values are adjusted based on various abundance indices: longline sentinel (1995 to 2016, ages 3 to 13); gillnet sentinel (1995 to 2016, ages 4 to 13); mobile sentinel ≥ 20 fathoms (1995 to 2002, ages 2 to 11); mobile sentinel ≥ 10 fathoms (2003 to 2016, ages 1 to 11); and the DFO survey (1990 to 2016, ages 1 to 11).

For the SPA, the *M* values were set at 0.2 from 1974 to 1985, at 0.4 from 1986 to 1996, and at 0.2 from 1997 to 2001. Thereafter, the *M* values were estimated by blocks, namely 2001–2004, 2005–2008, 2009–2012 and 2013–2016 (ages 3–12 years), using sensitivity analysis (*NFT VPA/ADAPT*). The estimated values were: M=0.30 for 2002 to 2004, M=0.42 for 2005 to 2008, M=0.52 for 2009 to 2012, and M=0.46 for 2013 to 2016. Possible explanations for the increase in natural mortality particularly from 2005 onward are seal predation and unaccounted fishing mortality.

There was a significant decrease in cod population abundance from the late 1980s to the early 1990s (Figure 9). It reached a high of 559 million in 1980 and a low of 31 million in 1994. This abundance remained low and stable until 2005, then exhibited a few fluctuations until 2014. The 2017 estimate (109 million) is the highest since 1991. There was a significant decrease in the abundance of mature individuals from 1982 to 1994, and it remained low and stable until 2014, at which point it increased until 2017. The abundance of three-year-old individuals estimated by SPA since 1990 was higher in 2007, 2008 and 2009 (2004 to 2006 cohorts), as well as during the past four years (Figure 10).

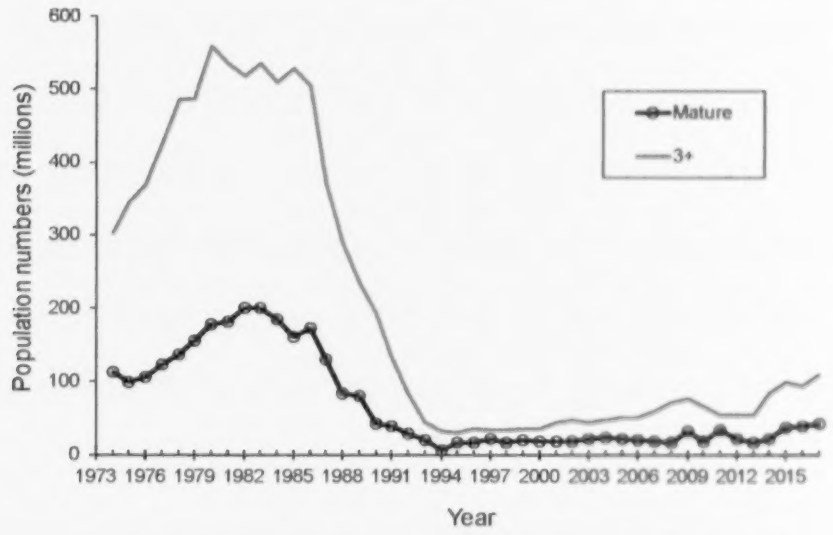


Figure 9. Total population (ages 3+) and mature population numbers estimated by SPA.

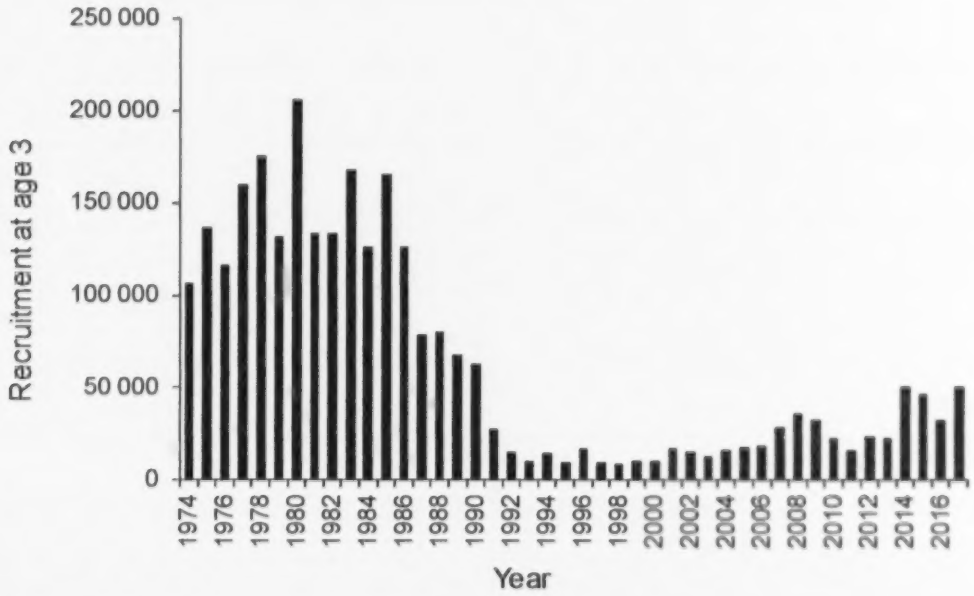


Figure 10. Number of three-year-old recruits estimated by SPA.

The spawning stock biomass has been in the critical zone, well below the limit reference point (LRP) of 116,000 t since 1990 and it has been increasing slightly since 2013. The estimated value for 2016 is 30,068 ± 2,655 t.

The exploitation rate for seven- to nine-year-old individuals, estimated using SPA, was high from 1997 to 2002, as well as in 2008, 2009 and 2010, and it decreased significantly from 2011 to 2016 (Figure 11) following TAC reductions.

Tagging

A total of 80 878 cod in the northern Gulf were tagged between 1995 and 2016 in a tagging program whose aim was to estimate an exploitation rate. Of this number, 7,255 tags were returned by fishers, 89% of whom were from areas 3Pn, 4R and 4S. The exploitation rate estimated from this tagging program increased from 2003 to 2007 before dropping to a low level, where it has been since 2011 (Figure 11).

Figure 11. Exploitation rate estimated by SPA for seven- to nine-year-old cod and by the tagging program for fish measuring 40 to 80 cm. The solid symbols represent the moratorium years.

Outlook

The NFT AGEPRO model was used to make spawning stock biomass projections for 2018 and 2019 from the SPA results. The projection indicates that, with an annual harvest of 1,800 t or 3,000 t, the spawning stock biomass (SSB) should increase. The estimated values for 2017, 2018 and 2019 are 37,075 t ± 4,498, 40,724 t ± 5,573 and 43,494 t ±7,658, respectively, based on a harvest of 3,000 t/year. However, the projected SSB for 2019 remains well below the limit reference point.

Sources of uncertainty

The addition of several days to the recreational fishery in 2016 has inevitably increased pressure on the fishery, which will probably translate into an increase in the harvest. It becomes necessary to improve training and monitoring concerning this activity in order to estimate the quantity of fish harvested and obtain fish samples (length and otoliths).

The tagging programs in recent years have been conducted exclusively in NAFO area 4R even though cod abundance is now similar between areas 4S and 4R. This could generate bias around the exploitation rate estimate.

CONCLUSION

This assessment indicates that the cod stock in the northern Gulf of St. Lawrence remains in the critical zone and well below the limit reference point estimated at 116,000 t. The 2017 estimate is at 32% of the limit reference point. The exploitation rate is currently at a low level and natural mortality is high. The spawning stock biomass could increase by 20% or 17% until 2019 based on an annual harvest of 1,800 t or 3,000 t, respectively, for the next two seasons.

OTHER CONSIDERATIONS

Survey

Since 1998, the Lower North Shore Fishermen's Association (LNSFA) and the Newfoundland- and Labrador-based Fish, Food and Allied Workers (FFAW) Union have been conducting a telephone survey (random draw) with fixed gear fishers who hold a directed cod licence. The objective is to document various issues related to northern Gulf of St. Lawrence commercial cod fisheries. The survey results indicate roughly the same trends as the commercial fishery CPUEs and the fixed gear sentinel fishery indices. The answers to the question about fishery performance indicate that yields were higher before 2007, decreased until 2009, increased again until 2014, and then stabilized in 2015 and 2016 for the three survey areas (3Pn, 4R and 4S) (Figure 12). Respondents also noted that the fish were smaller in 2008 and 2009 and that sizes had increased afterwards. No noticeable change in cod condition or migration profile was noted by the survey respondents.

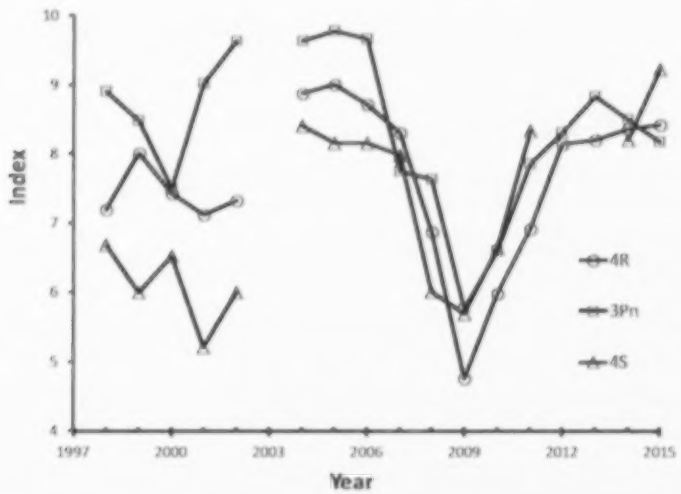


Figure 12. Performance index by NAFO Division from the telephone survey of fixed gear fishers.

Procedures for updates during intermediary years

This stock is assessed every two years and the next full assessment will be conducted in the winter of 2019. However, an update on the status of this stock will be completed in the winter of 2018. It will include data from the commercial fisheries, an abundance index calculated from the DFO research survey (4RS), abundance indices from the fixed gear sentinel program (gillnets and longlines), an abundance index derived from the mobile gear sentinel fishery program (3Pn, 4RS), and biological data.

SOURCES OF INFORMATION

This Science Advisory Report is from the February 23, 2017 meeting on the Assessment of the northern Gulf of St. Lawrence (3Pn, 4RS) Cod. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada Science Advisory Schedule as they become available.

Bourdages, H., Brassard, C., Desgagnés, M., Galbraith, P., Gauthier, J., Légaré, B., Nozères, C. and Parent, E. 2017. Preliminary results from the groundfish and shrimp multidisciplinary survey in August 2016 in the Estuary and northern Gulf of St. Lawrence. DFO Can. Sci. Advis. Sec. Res. Doc. 2017/002. v + 88 p.

Brassard, C., Gauthier, J., Schwab, P., Le Bris, A., Way, M. and Collier, F. 2016. The Status of the Northern Gulf of St. Lawrence (3Pn, 4RS) Cod (*Gadus morhua*) Stock in 2014. DFO Can. Sci. Advis. Sec. Res. Doc. 2016/010. xi + 123 p.

DFO. 2011. Recovery potential assessment for Laurentian North designatable units (3Pn, 4RS and 3Ps) of Atlantic Cod (*Gadus morhua*). DFO Can. Sci. Advis. Sec., Sci. Advis. 2011/026.

DFO. 2015. Assessment of the northern Gulf of St. Lawrence (3Pn, 4RS) cod stock in 2014. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2015/041.

DFO. 2016. Update of Indicators of the Status of the Northern Gulf of St. Lawrence (3Pn, 4RS) Cod Stock in 2015. DFO Can. Sci. Advis. Sec., Sci. Resp. 2016/009.

THIS REPORT IS AVAILABLE FROM THE:

Centre for Science Advice (CSA)
Quebec Region
Fisheries and Oceans Canada
Maurice Lamontagne Institute
P.O. Box 1000 1000 Mont-Joli
Quebec, Canada
G5H 3Z4

Telephone: 418-775-0825
Email: Bras@dfo-mpo.gc.ca
Internet address: www.dfo-mpo.gc.ca/csas-sccs/

ISSN 1919-5087
© Her Majesty the Queen in Right of Canada, 2017

Correct citation for this publication:

DFO. 2017. Assessment of the Northern Gulf of St. Lawrence (3Pn, 4RS) Cod Stock in 2016. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2017/042.

Aussi disponible en français:

MPO. 2017. Évaluation du stock de morue du nord du golfe du Saint-Laurent (3Pn, 4RS) en 2016. Secr. can. de consult. sci. du MPO, Avis sci. 2017/042.